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Ripple Marks

The Story Behind the Story

BY CHERYL LYN DYBAS

Coral Reef Discovered in an Unlikely Locale: The Amazon River's Freshwater Plume

Where is one of the last places on Earth scientists would look for a new coral reef?

Perhaps the mouth of the Amazon River, where huge freshwater outflows meet the Atlantic Ocean. But that's exactly where researchers found a thriving reef complex.

"It may be an unfavorable coral reef environment, but nonetheless a vibrant reef exists there," says Fabiano Thompson of the Universidade Federal do Rio de Janeiro (UFRJ) in Brazil, one of several co-authors of a paper on the discovery published on April 22, 2016, in the journal *Science Advances*.

REEF IN A RIVER PLUME

The Amazon's outflow, or plume, covers 1.3 million square kilometers, ultimately reaching the Caribbean Sea. It represents 20 percent of the global river discharge to the ocean. Every second, the Amazon ferries 175 million liters of freshwater mixed with sediment to the Atlantic. Little sunlight penetrates this turbid mixing zone where river and sea meet. The bottom is covered with mud, and nutrient concentrations vary—conditions not usually associated with coral reefs, says lead paper author Rodrigo Moura, also of Brazil's UFRJ.

How was the reef discovered? Scientists from nine institutions recently conducted an expedition to the mouth of the Amazon to map the ocean bottom. Previous studies in the 1970s and 1980s reported single samples of reef-like structures. None, however, suggested the existence of a large reef system beneath the Amazon's plume.

The latest expedition was primarily focused on understanding the mouth of the Amazon, says Patricia Yager, an oceanographer at the University of Georgia who took part in the research. "But Rodrigo Moura had an article from the 1970s that mentioned reef fish along the continental shelf. He wanted to try to locate the reef."

Another clue: Fishing boats have long plied the plume's waters. The fishers' main targets are groupers and red snappers—reef fish.

The challenges of melding 1970s map coordinates with modern GPS technology aside, the research team ultimately succeeded in finding the reef and retrieving samples to confirm its existence. "We brought up the most amazing and colorful animals I've ever seen on an expedition," says Yager.

The reef forms a coral complex that reaches depths of 10 to 120 meters. Its calcareous algae, sponges, corals, and hydrocoral colonies have existed for as long as 13,000 years, and provide habitat for 73 species of fish and six species of lobsters.

CORAL REEF – FRESHWATER RIVER RELATIONSHIP RECONSIDERED

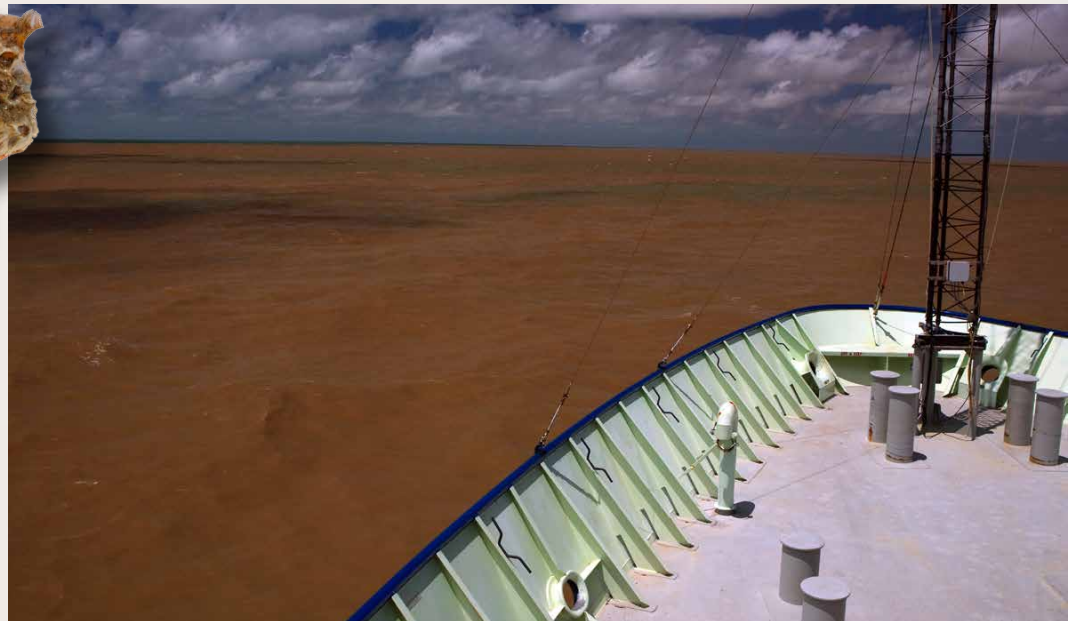
The reef is a continuation of the Manuel Luiz reefs in the northeastern region of Brazil and is a unique system, scientists say. Many of the Amazon reef structures are 300 meters long and 30 meters high.

"It's a paradigm shift in geology and biology," says Michel Mahiques, a geologist at the Oceanographic Institute of the University of São Paulo in Brazil. Mahiques led the team that mapped the seafloor using sonar technology.

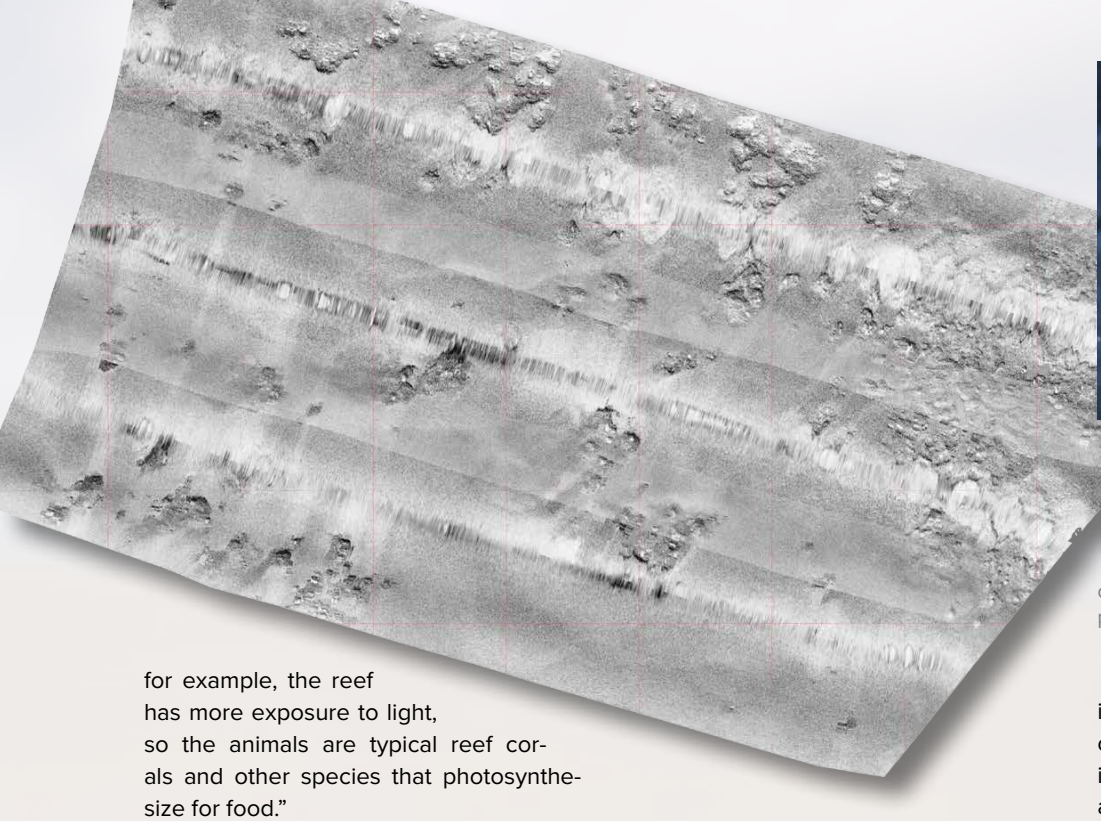
A REEF FOR THE TEXTBOOKS – AND THE AGES

"This discovery is not just about the reef itself, but about how the reef community changes from south to north," says Yager. "That's in response to how much light each area receives, a result of the Amazon plume. In the southern section,

(above) Mollusc shell covered with barnacles and other reef builders. *Photo courtesy of J. Landrum*



(right) R/V *Atlantis* on the Brazil shelf. *Photo courtesy of L. Willis*



(above) Reef sample collected off the Amazon River mouth. *Photo courtesy of R. Moura*

(left) Side-scan sonar mosaic showing numerous reef mounds. Swath width for one sonar pass is ~300 m. *Image courtesy of M. Mahiques*

for example, the reef has more exposure to light, so the animals are typical reef corals and other species that photosynthesize for food."

Moving north, the plume's sediment-laden outflow darkens the ocean waters. The reef transitions from photosynthesizers to sponges and other reef-builders that live on food the plume delivers.

The ages of the three reef sections are different: 13,000 years old in the northern section; 4,500 years old in the central section; and 150 years old in the southern section. Other important characteristics, the scientists say, are the reef's topography, with apparent ridge-like structures in the southern section. Mud is abundant in the northern section but almost absent in the central and southern sections.

DRAMATICALLY CHANGING VIEW OF REEF ENVIRONMENTS

"The Amazon reef defies our knowledge of the ecological balance of such environments," says Thompson. Reefs are usually found in warm seas with constant salinity levels, high light levels, and oxygen and biomass generated by photosynthesizers.

At least two-thirds of the system—the northern and central sections—thrives beneath the dark waters of the Amazon plume, thanks to chemosynthesizing microorganisms that transform minerals into food.

These chemosynthesizers support a complex ecosystem that exists in low light and low oxygen levels. "Many sponges can live in these conditions, and are more tolerant of dark, oxygen-deprived waters than corals and coralline algae," says Thompson.

Molecular and genetic analyses will likely identify new microorganisms and sponge species along the reef, the biologists believe.

REEF AT RISK

In spite of its recent discovery, the Amazon reef is already at risk. "Remarkably, 125 exploratory blocks for oil drilling in the Amazon [continental] shelf were offered in an international auction in 2013," state the scientists in their paper, "35 of which were acquired by domestic [Brazilian] and transnational companies. In the past decade, a total of 80 exploratory blocks have been acquired for oil drilling in the study region.

"Some 20 blocks will soon be producing oil in close proximity to the reef," the co-authors continue, "but the environmental baseline compiled by the companies and the Brazilian government is still incipient and largely based on sparse museum specimens."

If these companies knew about the reef, says Thompson, "they didn't publish the information broadly." He and other researchers believe that such large-scale industrial activity threatens the existence of the reef system. The scientists are asking for a more complete environmental assessment of the reef before "impacts become extensive and conflicts among stakeholders escalate," Thompson says.

FUTURE OF A FRAGILE REEF

Coral reefs are in global decline, with losses of biodiversity as a result of pollution, overfishing, warming waters, and ocean acidification.

"The Amazon system, however, has survived for thousands of years in conditions that can be compared to predicted future climate scenarios," says Thompson. "This reef may offer important insights into the decades ahead for all coral reefs."

The researchers recommend further studies of the reef "related to sensitivities in the hydrologic cycle of the Amazon—where extreme droughts and floods are on the increase and will influence the functioning of this novel reef system."

The abundant sponges in the central section, for example, point to a possible overall shift from a coral-dominated to a sponge-dominated reef.

Barely discovered—and despite its longevity—the Amazon River plume reef has become a moment-in-time, already changing before our eyes.

Cheryl Lyn Dybas (cheryl.lyn.dybas@gmail.com), a Fellow of the International League of Conservation Writers, is a contributing writer for *Oceanography* and a marine ecologist and policy analyst by training. She also writes about science and the environment for *National Geographic, BioScience, National Wildlife, Natural History, The Washington Post, Yankee, and many other publications*.